Clinical signs, treatment, and outcome in 15 cattle with sinonasal cysts

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Abstract: Objective: To evaluate clinical signs, diagnosis, treatment and outcome of cattle with sinonasal cysts. Study Design: Case series. Animals: Cattle (n = 15). Methods: Medical records (2004–2011) of cattle with a fluid-filled mass in the nasal cavity, conchae, and/or paranasal sinuses were evaluated. Data retrieved and analyzed were reason of presentation, clinical signs, diagnostic techniques, surgical treatment, complications, and outcome. Results: Common presenting clinical signs were abnormal respiratory noise, nasal discharge, and abnormal respiratory effort. Mean age of affected cattle was 21.7 months. In 9 animals, cysts were identified by endoscopy. Radiographic signs included a mass in the paranasal sinuses or conchae (13), nasal septum deviation (12), fluid lines (10), and bone atrophy (5). Ten cattle were treated surgically with osteoplastic flap techniques to gain access to the frontal or maxillary sinus (5), nasal extraction of the cyst under endoscopic control (3) or a combination of both techniques (2). Nine cattle returned to be productive members of their herd and had no recurrence (mean follow-up, 20.7 months). Conclusions: Sinonasal cysts should be considered as a primary differential diagnosis in cattle with abnormal respiratory noise, particularly in younger animals. Multiple cysts were common, which underlines the importance of a thorough preoperative examination using appropriate imaging modalities. Despite the often expansive nature of sinonasal cysts, the prognosis with surgical treatment was good.

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RUNNING HEAD: Sinonasal Cysts in Cattle

Clinical Signs, Treatment, and Outcome in 15 Cattle with Sinonasal Cysts

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ABSTRACT

Objective: To evaluate clinical signs, diagnosis, treatment and outcome of cattle with sinonasal cysts.

Study Design: Case series

Animals: Cattle (n=15)

Methods: Medical records (2004-2011) of cattle with a fluid-filled mass in a nasal cavity, conchae, and/or paranasal sinuses were evaluated. Data retrieved and analyzed were reason of presentation, clinical signs, diagnostic techniques, surgical treatment, complications, and outcome.

Results: Common presenting clinical signs were abnormal respiratory noise, nasal discharge, and abnormal respiratory effort. Mean age of affected cattle was 21.7 months. In 9 animals, cysts were identified by endoscopy. Radiographic signs included a mass in the paranasal sinuses or conchae (13), nasal septum deviation (12), fluid lines (10) and bone atrophy (5). Ten cattle were treated surgically with osteoplastic flap techniques to gain access to the frontal or maxillary sinus (5), nasal extraction of the cyst under endoscopic control (3) or a combination of both techniques (2). Nine cattle returned to be productive members of their herd and had no recurrence (mean follow-up, 19.3 months).

Conclusions: Sinonasal cysts should be considered as a primary differential diagnosis in cattle with abnormal respiratory noise, particularly in younger animals. Multiple cysts

were common, which underlines the importance of a thorough preoperative examination using appropriate imaging modalities. Despite the often expansive nature of sinonasal cysts, the prognosis with surgical treatment is good.

INTRODUCTION

Sinonasal cysts are non-neoplastic fluid-filled structures within the nasal passages, paranasal sinuses and conchae.[1-4] Based on the type of epithelial lining of one or both sides of the cyst wall, sinonasal cysts are divided into 3 categories: dermoid cysts, dental residual cysts and cysts lined by stratified respiratory epithelium[1]. There are usually thin plates of bone in the cyst wall and the walls may have signs of ulceration.[1] Clinical signs in cattle and horses are unilateral mucopurulent nasal discharge, respiratory noise, nasal obstruction and/or facial swelling.[3, 5-11] Differential diagnoses include nasal granuloma, nasal polyps, foreign bodies, skull fracture, primary or secondary sinusitis and tumors.[2, 5, 11] Radiographically, cysts appear as well-demarcated masses of soft-tissue density in the sinonasal space, often accompanied by a horizontal fluid line within a paranasal sinus and deviation of the nasal septum. [2-4] A partially mineralized capsule is considered a further characteristic finding.[2] Depending on the size of the cyst, it may become obscured by the fluid. Bony changes involving the nasal passages were observed in 97% of horses with sinus cysts.[2] Computed tomography (CT) has been used to determine the location and size of cysts in both cattle and horses.[12, 13] There have been several retrospective studies and reviews on sinonasal cysts in horses;[1-3, 14-19] however, in cattle studies have been limited to case reports of cystic conchae and sinus cysts. [6-9, 10]

Treatment options for conchal cysts in cattle include removal using obstetric wire introduced through the nose or by laryngotomy,[8,9] or removal through the nares with or without use of an endoscope. [5] Complete or partial removal of sinonasal cysts in cattle and horses has been described using a nasofrontal or maxillary bone flap approach,[6, 7, 10, 18, 20] trephination of the maxillary sinus or sinoscopy.[10,16, 17, 21] To prevent recurrence of

the lesion and chronic nasal discharge, complete removal of the cystic lining has been recommended in 2 studies.[4, 19] Although there have been no reports of cyst recurrence after treatment of sinonasal cysts in cattle[6-10] and horses,[3, 4, 19, 20] cases with persistent mucopurulent nasal discharge have been reported.[3]

Our purpose was to describe the diagnosis, treatment and outcome of 15 cattle with sinonasal cysts.

MATERIALS AND METHODS

Medical records (2004-2011) of 15 cattle referred because of a fluid-filled mass in a nasal cavity, conchae, and/or paranasal sinuses were reviewed. Only cases with a confirmed intraoperative diagnosis, necropsy, or results of fine needle aspiration were included. Reason for referral, clinical signs, diagnostic techniques used, surgical treatment, complications and outcome were recorded.

Diagnosis

All cattle were examined clinically and all but one had upper airway endoscopy. Radiography and CT of the head were done in 13 and 10 cattle, respectively. A conventional axial (3rd generation) CT unit (Siemens SOMATOM AR.T, Siemens AG, Fahrweid, Switzerland) was used in the first 3 cattle, and a multidetector CT unit (Siemens SOMATOM SENSATION OPEN, Siemens AG, Erlangen Germany) in the other 7 cattle. Radiographs and CT images were reviewed by the same clinician (RH) who was unaware of the identity of the cattle. Images were evaluated for number and location of cysts (left or right side, maxillary, palatine or frontal sinus, dorsal or ventral concha), atrophy or deformation of the nasal septum, concha or facial bones, and dental involvement. The results of these assessments were compared with intraoperative or necropsy findings.

Histologic, Cytologic, and Bacteriologic Examination

Histologic evaluation of cysts was made for 13 cattle. Fluid from the cysts was collected via fine needle aspiration and assessed macroscopically in 12 cattle and cytologic and bacteriologic evaluation of the fluid performed on 4 of these specimens. Eleven fluid samples were collected intraoperatively or at necropsy and 1 during endoscopic examination.

Treatment

Ten cattle were treated surgically, 4 were euthanatized and examined at necropsy. One animal was slaughtered elsewhere and could not be examined by necropsy.

Bone Flap Techniques

Surgical access using bone flap techniques was used in 7 cattle and included a frontonasal or maxillary bone flap approach, based on cyst location.[4, 22] The exact location and size of the bone flap was chosen according to the size and age of the animal and size of the cyst(s). All bone flaps were created with an axial base. In 1 animal with severe atrophy of the maxillary bone, the flap fractured and the abaxial two thirds could not be reattached (Fig1). In the other cattle, the flap was replaced; cerclage wire was used to secure the abaxial corners when required.

Nasal Extraction of Cysts using Endoscopic Guidance

In 3 cattle, cysts were removed through the nasal cavity using endoscopic guidance. Cysts were grasped with large surgical (eg, Allis tissue forceps) or laparoscopic forceps (eg, Allis grasping forceps, Semm claw forceps), and an attempt was made to remove as much of the cyst wall as possible. Two cattle with multiple cysts were treated using a bone flap technique as well as nasal extraction of the cysts.

Anesthesia and Medical Treatment

In 1 case, a solitary cyst was extracted through the nose in the standing position with the animal mildly sedated. The other procedures were performed under inhalation anesthesia with the animal in lateral recumbency and the affected side uppermost. Lactated Ringer's solution intravenously (IV) was administered during surgery and anesthesia.

Cattle were administered amoxicillin (7 mg/kg intramuscularly once daily), or sodium penicillin (30,000 U/kg IV every 12h) and gentamicin (4 mg/kg IV once daily). Ketoprofen (3mg/kg IV once daily) or flunixin meglumine (1.1mg/kg IV once daily) were administered 1 hour before surgery and continued for 3-5 days postoperatively.

Intraoperative Complications and Additional Therapeutic Measures

Tracheotomy with placement of a tracheostomy tube[23] was required in 1 animal to facilitate breathing while the nasal passage was packed with stockinet filled with saline-soaked gauze,[4] and in another until removal of multiple cysts was accomplished. Two other cattle had blood transfusions during surgery.

Follow–Up Examination

Telephone interviews of owners of 10 cattle, 6 months to 4 years (mean, 20.7 months; median, 24 month) after surgery was used to assess owner satisfaction, cosmetic outcome, level of production, recurrence of clinical signs, and date and reason for slaughter in cattle no longer alive. For 6 cattle, follow-up time was > 1 year.

RESULTS

There were 13 Swiss Braunvieh, 1 Simmental and 1 Holstein Friesian, ranging in age from 7 months to 3.5 years (mean, 21.7 months), and all but 1 were female.

The most common reasons for referral were increased respiratory noise (n=15), abnormal respiration (11), and nasal discharge (9). Clinical signs were first noticed <1 month before referral in 8 cattle and between 2 and 4 months before referral in 4 cattle. In the other 3 cattle, clinical signs were present for a longer time, but the exact duration was unknown.

Demeanor and general body condition were considered normal in 3 cattle, mildly abnormal in 6 and moderately to severely abnormal in 6 others. All of the clinically abnormal cattle had abnormal breathing and 2 were open-mouth breathing. All cattle had nasal respiratory noise, which was audible only during inspiration in 4 and during inspiration and expiration in 11. Three cattle had firm unilateral facial swelling over the maxillary sinus; the overlying skin was normal.

Endoscopic Findings

In 9 of 14 cattle examined endoscopically, the endoscope could not be advanced to the larynx on the affected side because of narrowing of the nasal passage. In 4 cattle, the cyst/cysts caused septum deviation and narrowing of the contralateral nasal cavity and 1 of these, there was sufficient narrowing to restrict passage of an endoscope. In 2 cattle, the cyst protruded several centimeters toward the contralateral side caudal to the nasal

septum. The cyst walls were smooth and white to yellow, red or dark blue. Three cattle had conchal cysts covered by apparently normal mucous membrane (Fig 2). Other findings included severe hyperemia of the nasal mucosa in 3 cattle, severe follicular pharyngitis in 4 and pharyngeal collapse during inspiration in 2 cattle.

Diagnostic Imaging Findings

Radiographic findings included a mass in a paranasal sinus or the conchae in all cattle, nasal septum deviation in 12, fluid lines in 10, and bone atrophy in 5. Mild deformation of the maxillary bone was observed in 5cattle and changes in the ethmoid bone were observed in 5 others. There were no radiographic signs of dental involvement. In 7 cattle, 1 or multiple radiopaque sinonasal masses were seen. Accurate diagnosis of the number and location of multiple cysts or cysts in more than 1 sinus cavity (Fig. 3) was not possible using radiography.

CT allowed exact determination of the location, number and size of the cysts in all cattle (Fig 4), and only CT allowed assessment of deformation or atrophy of the bony septa of the paranasal sinus and conchae. In 3 cattle, the infraorbital canal was deformed or atrophied because of pressure from the cyst.

In 1 of the 2 cattle that did not have preoperative CT, bilateral dorsal conchal cysts were missed during the initial surgery and had to be removed in a 2nd procedure 4 months later. This heifer had recurrence of nasal respiratory noise after initial treatment.

Surgical Findings

Five heifers were successfully treated using a bone flap technique alone. Complications were severe hemorrhage in 2 caused by separation of the cyst from the underlying tissue. This was successfully controlled by packing the affected nasal meatus with a gauze-filled stockinet and by transfusing 10L of blood. Moderate hemorrhage in the 3 other heifers was also controlled by packing the affected nasal meatus with a gauze-filled stockinet. A Foley catheter was placed into the maxillary sinus of 1 heifer before closure to facilitate postoperative flushing. Creation of a maxillary bone flap caused rupture of the ipsilateral infraorbital nerve and hemorrhage in 1 animal with a deformed infraorbital canal.

Nasal Extraction of Cysts using Endoscopic Guidance

Extraction of the cysts through the nasal cavity alone was successful in 3 of 5 cattle in which this was the first treatment approach. Draining the cysts beforehand facilitated their removal. Hemorrhage was minimal and packing of the nasal canal was not required.

Two cattle required a combination of extraction via the nares and a bone flap technique. In the first, only partial cyst removal was possible via the nostrils because of lack of space, but complete removal was achieved using a bilateral frontonasal bone flap

technique. In the 2nd animal, an additional maxillary bone flap was required to remove a maxillary sinus cyst.

Surgical time required varied with the type of attachment, localization and number of cysts, and ranged from 20 minutes to 2.5 hours (mean, 99.5min; median, 105min).

Postoperative Period

In the 5 cattle with moderate to severe hemorrhage, first the gauze and then the stockinet were removed after 48 - 72 hours. In the 2 heifers that had a tracheotomy, the tracheostomy tube was removed just after the stockinet, and the tracheotomy site was cleaned once or twice daily as required. The Foley catheter used for flushing the sinus was removed 2 days after surgery.

Abnormal respiratory noise disappeared immediately after surgery in 4 cattle, after removal of the stockinet in 5 heifers that had hemorrhage and after flushing of the nasal canal during endoscopic re-examination to remove blood clots in 1 animal.

Endoscopic re-examination 3-5 days after surgery revealed fungal infection of the nasal mucosa, largely associated with remaining blood clots, in 5 of 10 cattle. Except for mild nasal discharge, this did not cause problems and resolved after flushing of the nasal cavity 2 or 3 times with povidone-iodide solution diluted in isotonic saline solution. There was transient swelling of the incision sites of all bone flaps. In 1 animal, this was

accompanied by mild purulent discharge, which resolved after a few days. There were no bone sequestra or fistulous tracts associated with the bone flaps.

The 10 operated cattle were discharged from the hospital 3-29 days (mean, 14 days) after surgery. The 2 cattle that required tracheotomy were hospitalized for 19 and 24 days to allow adequate wound healing.

Necropsy Findings

Cysts in multiple locations were confirmed in 2 cattle. In the other 2 cattle, 1 of which had a single cyst and the other multiple cysts in a ventral concha, the origin of only 1 cyst could be determined, which was the ethmoid bone.

Cyst Location

There was good agreement between CT images and intraoperative findings, and bone lesions diagnosed using CT could be verified at surgery. The most common location of sinonasal cysts was the ventral nasal concha (8/15); cysts were found in both ventral conchae in 2 cattle (Fig. 5). The maxillary sinus and the ipsilateral palatine sinus was affected in 2 cattle (Fig. 6), and in 3 other cattle, there were multiple cysts in the maxillary and palatine sinuses and ventral and dorsal conchae. In 2 cattle with multiple cysts, the origin of 1 cyst could be traced to the nasomaxillary aperture (Fig. 7). In 2 other cattle, the origin of one cyst in the ventral concha could be traced to the ethmoid bone. In

the remaining cattle, the origin could not be determined because of extensive skeletal deformation or because of incomplete case records.

Cytologic Findings

Macroscopic evaluation of the content of the cysts in 12 cattle revealed yellow serous fluid (n=4), seromucoid, opaque and slightly hemorrhagic fluid (5), brown and malodorous fluid (2) or purulent material (1). In 4 of these cases, cytologic evaluation of the cyst content showed no signs of infection in 3 cases that had serous fluid. The cell count varied from 8 - 800 cells/µL, the protein concentration from 30 - 54 g/L and the specific gravity from 1.024 - 1.034. Macrophages were the predominant cell type. The content of the cyst in the 4th animal was opaque and had a cell count of 27x10^{9} cells/µL with predominantly neutrophils, a specific gravity of 1.010, and numerous extracellular and intracellular bacteria.

Bacteriologic Findings

The cyst contents were sterile in 3 cattle and yielded large numbers of *Pasteurella* spp. in 4th animal. The organisms were seen within neutrophils as well as extracellularly.

Histologic Findings

Cyst walls consisted mainly of loose collagenous connective tissue with a central plate of regularly arranged woven bone (Fig 8). With 1 exception, the cyst wall was lined with

ciliated respiratory epithelium, which had numerous large erosions or ulcerations (n=7) or a few areas of squamous cell metaplasia (5). Bacterial colonies were seen on the ulcerated surface of the cysts in 3 animals. All cyst walls had moderate to severe chronic inflammation, which was predominantly lymphoplasmacytic. The cysts of 2 cattle had severe granulomatous inflammation, which was associated with microscopic evidence of bacteria in one. The histologic diagnosis was non-neoplastic cyst in 1 case and non-neoplastic cysts lined by stratified respiratory epithelium in the others.

Follow up and Outcome

One heifer that had been operated because of bilateral conchal cysts had further cysts removed surgically 4 months after the initial surgery. Radiographs but not CT images had been taken initially; however, CT scans done before and 7 months after the 2nd surgery showed that the atrophied and deformed ventral conchae, diagnosed before the 2nd surery, had regenerated (Fig 9). This animal was included in the follow up after the 2nd surgery.

Eight of 10 treated cattle were alive at the time of the follow up. In 1 cow respiratory noise recurred 1 year after surgery, but this did not affect breathing or wellbeing. This animal was slaughtered 22 month after surgery for other reasons, but was not available for necropsy. Another cow was slaughtered because of poor production. The remaining 8 cattle had no complications after discharge and were healthy at the time of telephone follow up. Owners were satisfied with the outcome and the productivity of the surviving cattle. The cosmetic results after removal of the cysts via the nasal passage and the bone

flap technique, including the appearance of 2 cattle with deformation of the maxillary bone, were considered very satisfactory by the owners.

DISCUSSION

We found that sinonasal cysts are a disease of relatively young cattle because all but one female were nulliparous. The most common clinical signs were respiratory noise, abnormal breathing, and nasal discharge. Deformation of the nasal septum, conchae and walls of the paranasal sinuses was commonly encountered; however, in contrast to horses, visible deformation of the skull occurred in only 3 of 15 cattle.[1,3,4] A possible explanation for this difference is that in cattle, maxillary sinus cysts expand into the palatine sinus; in all 5 cattle with maxillary sinus cysts, the palatine sinus was also affected. The ventral conchae were affected in 8 of 15 cattle, which made this the most common location of the cysts in agreement with other studies in which the conchaewere more frequently affected than the maxillary sinuses.[6, 16-19] This differs from horses, where sinonasal cysts are most commonly found in the caudal compartment of the maxillary sinus.[2, 3]

Thirteen (87%) cattle were Swiss Braunvieh or related to this breed, although Braunvieh cattle composed only about one third of our general patient population. Examination of the pedigrees of these cattle did not reveal a common ancestry, making a genetic component unlikely. Previously published case reports involved various breeds including Brangus, Aberdeen Angus and Holstein and all were male cattle.[6,8-10] In contrast, all but 1 of our cattle were female. A possible reason for this difference is that Swiss Braunvieh are dairy cattle and most bull calves are slaughtered at a very young age.

Nine cattle were referred at a relatively advanced stage of disease, when the size of the cysts prevented comprehensive endoscopic examination of the nasal passage on the affected side. Despite this limitation, endoscopic examination of both nasal passages is recommended to facilitate the selection of the surgical approach, especially if CT examination is not an option.

Solitary cysts without significant bony involvement can be diagnosed and localized with lateral, dorsoventral, and 2 oblique radiographic views of the maxilla. Multiple or large expansive cysts, on the other hand, are difficult to diagnose radiographically because of superimposition. Without CT, some of these cysts are easily missed, even when radiographic examination is supplemented with endoscopic examination. Identification of the site of origin of large cysts associated with skeletal deformation and atrophy was difficult using radiography, but was straightforward using CT. The higher cost of CT is offset by an accurate diagnosis and more efficient selection of appropriate treatment.

Multiple cysts occurred in one third of our patients. The cysts were in the paranasal sinuses and conchae in 3 cattle, and in 2 others, they occurred bilaterally in the ventral conchae.

Depending on their localization, sinonasal cysts may be treated by extraction through the nares, bone flap techniques or a combination of the 2 techniques. The latter is indicated for multiple cysts. Extraction of cystic conchae through the nostrils is minimally invasive because a natural body orifice is used. Pedunculated cysts close to the

nostrils are easily removed using this technique, but multiple cysts or those with a wide base are more difficult to remove. Hemorrhage occurred after removal of part of the cysts and caused poor visibility and prolonged surgical time. It may be possible to minimize these complications by using alternative techniques such as laser surgery or high-frequency electrocautery with a sling.

Both frontonasal and maxillary bone flap techniques were suitable for the removal of sinonasal cysts. A bilateral frontonasal approach was chosen for bilateral cysts to protect the nasal septum.[7] Severe deformation or atrophy of adjacent bones by cysts did not impair surgical outcome. Postoperative complications were minimal with both techniques, even when combined for treatment of cattle with bilateral cysts.

Recurrence of respiratory noise occurred in 1heifer, in which multiple cysts had been diagnosed by radiography. CT had not been performed before initial surgery and it is therefore possible that a cyst, missed on initial radiographs, had enlarged causing respiratory noise. The previously affected ventral conchae appeared healthy on CT images taken 7 months after the 2nd surgery, which suggests a remarkable potential for conchal regeneration. Confirmation of this observation would require systematic pre- and postoperative CT examinations. Conchal regeneration was also observed in piglets that had recovered from atrophic rhinitis or from experimental infection with *Bordetella bronchiseptica.*[24-26]

In agreement with published reports,[3, 14] the histologic structure of most cyst walls in our cattle consisted of fibrous connective tissue and plates of woven bone, covered on both sides by respiratory epithelium. Similar to sinonasal cysts in horses,[14] histologic signs of chronic inflammation were commonly seen in the cyst wall.

Chronic inflammation of the nasal passages with secondary obstruction of the communicating regions between the nasal sinuses and nasal cavity has been suggested as a possible cause of sinonasal cysts.[7, 8] Congenital malformation of the mucociliary clearance mechanism and growth disturbance of the ventral conchae have been discussed as possible reasons for conchal cysts, particularly when they occur bilaterally and in younger cattle.[18] An association between progressive ethmoidal hematoma (PEH) and narrowing of the nasomaxillary opening has been discussed in the etiology of sinonasal cysts in horses.[3, 10] Although the ethmoid bone was identified as the origin of the cysts in 2 cattle, there were no signs of PEH. Cysts originated from the nasomaxillary opening in 2 other cattle, but the origin was not determined in the other 11 cattle. Five cattle had an incomplete set of radiographic views or poor quality films and it is possible that more detailed surgical reports would have helped to identify the cyst origin in these cases and others. Alternatively, necropsy of a large number of cattle with sinonasal cysts are needed to determine the exact localization, origin and size of the cysts and to investigate pathogenesis. Surgical treatment of sinonasal cysts has a good prognosis and should be considered if economically feasible.

Sinonasal cysts should be considered an important differential diagnosis in cattle with respiratory noise, particularly in younger animals. One third of the cattle in this study had multiple cysts, which underlines the importance of a thorough preoperative examination using all available imaging modalities. The diagnostic tool of choice is CT but endoscopy and radiography are also useful. Surgical removal of sinonasal cysts has a good prognosis and led to complete long-term remission of clinical signs in 9 of 10 treated cattle.

DISCLOSURE

The authors report no financial or other conflicts related to this report.

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FIGURE LEGENDS

Fig. 1: Intraoperative view of a 20-month-old Swiss Braunvieh heifer with multiple sinonasal cysts. One cyst is being removed via a left maxillary bone flap. The bone was severely atrophied and the flap fractured parallel to its base. Orientation r= rostral, d= dorsal.

Fig. 2: Preoperative endoscopic view of the nasal passage in a 14-month-old Holstein heifer with ventral conchal cysts. The ventral nasal meatus is almost completely obstructed by the cystic ventral concha (v), which is covered by normal mucosa.

Fig 3: Radiographic study of the head of a 16-month-old Brown Swiss heifer. Lateral (3a), right dorsal left ventral oblique (RDLVO)(3b), left dorsal right ventral oblique (LDRVO)(3c) projections show two ovoid sinonasal cysts, one located in the left ventral concha (v) and one in the left dorsal concha (d). The radiopaque contour of the cysts likely reflects the bony wall. The maxillary and palatine sinuses are fluid-filled.

Fig 4: Computed tomographic images of the head of the heifer shown in Fig. 3. Transverse sections at the level of the diastema (4a) and 2nd molar (4b) show two cysts on the left side in the ventral (v) and dorsal (d) conchae. The nasal septum (s) deviates to the right. An additional cyst, which was not visible on radiographs, is seen in the right dorsal concha (d). Both maxillary sinuses (m) and the left palatine sinus (p) contain fluid attenuating material.

Fig 5: Computed tomographic image of the head of the heifer shown in Fig. 2. Transverse section at the middle of the second premolar; There is bilateral cystic degeneration of the ventral conchae (v) and bilateral obstruction of the nasal passages. The cysts on the left are cavitated.

Fig. 6: Transverse CT images of the head of a 31-month old Swiss Braunvieh cow with sinonasal cysts. Transverse sections are in rostral-to-caudal order (a-b) and show a cyst in the left palatine sinus (P), atrophy and deformation of the bony border between the nasal passage and palatine sinus (*), and the expansion of the cyst into the left maxillary sinus (M) and toward the

contralateral side. The right infraorbital canal (l) is normal; sections of the left infraorbital canal are completely atrophied.

Fig. 7: Intraoperative endoscopic view of the nasal passage of the heifer shown in Fig. 1. The region of the nasomaxillary opening (o) is distinct because of its deformation. A remnant of a cyst (c) is clearly visible at the nasomaxillary opening and grasped with laparoscopic forceps to be removed.

Fig. 8: Histological section of the wall of a sinus cyst, surgically removed from a 7 month old Swiss Braunvieh bull. The wall consists of loose collagenous connective (c) tissue and a central plate of evenly arranged woven bone (b) with columnar respiratory epithelium (e) on both sides. There is mild subepithelial lymphoplasmacytic infiltration. H&E; bar=200 µm

Fig. 9: Transverse CT images at the level of the fourth premolar of a Swiss Braunvieh heifer with recurring respiratory noise four months after surgical removal of 2 sinonasal cysts.
(9a): Image taken four month after the first surgery, showing a cystic mass, no conchal definition, and deformation of the nasal septum to the right. Subsequent to CT examination 2 dorsal conchal cysts were removed with frontonasal bone flap technique. (9b): Image taken seven months after the second surgery, showing a reduced deviation of the nasal septum. A slight deformation is still present, but also good definition of the ventral conchae, which indicates regeneration.